

2.5 Human Factors and Aviation Medicine

Mission

The Human Factors and Aviation Medicine program will:

- Identify, through applied research, methods that, when implemented, help achieve the goal of reducing the fatal accident rate by 80 percent
- Ensure, through innovative research and management initiatives, that human factors issues are addressed in acquiring and integrating all new and modified FAA aviation systems
- Review medical patterns in civilian flight
- Develop recommendations for protective equipment and procedures
- Provide options for FAA regulatory and medical certification staff charged with developing safety standards and regulations addressing all aircraft cabin occupants

The rapid evolution toward increased operational demand, diversity of aircraft and systems, changing technology, and globalization of the airline/aircraft industry challenges the Human Factors and Aviation Medicine Offices to meet the above goals by:

- Ensuring that research is focused on areas directly affecting aviation safety
- Capitalizing on opportunities to leverage government and industry resources
- Forming partnerships with research and university laboratories to rapidly transfer the results of research to the aviation community
- Undertaking major efforts to ensure that human factors expertise is represented across functional disciplines and that human factors considerations are addressed throughout the FAA acquisition process

Intended Outcomes

Human Factors. This research increases NAS safety and efficiency by developing scientifically validated information and guidance for improving performance and productivity of air traffic controllers and NAS system maintenance technicians.

This program responds directly to FAA Strategic Plan goals to “eliminate accidents and incidents caused by human error” and to “implement new decision support systems and associated functional improvements that fully account for the proper role of people in the system.” This research also provides human factors support that addresses the FAA goal to “reduce the costs of flying by making the air traffic management system more efficient to use.”

Human factors research is developing human-centered flight controls and displays and is increasing consideration of human factors in aircrew training. This research also explores prospects for safety enhancement through automated statistical analysis of flight-recorded data and through certification of new aircraft and equipment design and modification.

In aviation maintenance, human factors research develops more effective methods for maintenance technician and inspector training, and it improves aviation maintenance technician and inspector task performance.

In general aviation (GA), safety is enhanced through understanding and improving pilots’ decisionmaking skills.

Aviation Medicine. This research improves the health, safety, and survivability of aircraft passengers and aircrews by identifying human failure modes and developing formal recommendations for counteracting measures.

Through this research, the FAA develops bioaeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments as a basis for regulatory action to enhance appropriate human performance. New medical criteria, standards, and assessment/certification procedures are also developed to ensure full performance capability. Assessing flight attendant and passenger behavior and disease issues will lead to the development of guidelines to protect the health and improve the safety of cabin occupants.

Program Area Outputs

The Human Factors research program:

- Identifies operational needs and problems involving human performance
- Funds and guides research programs to address operational priorities
- Forms partnerships with industry and academia
- Elicits participation by the Nation's top scientists and professionals
- Provides Human Factors guidance to the FAA for development and implementation of new technologies
- Facilitates transfer of research products to the operational community

The Aviation Medicine research program:

- Produces data and other forms of information that support notices and regulations applicable to aircraft occupant health and safety
- Develops output options to solve a public demand (e.g., better restraints for children in aircraft settings)
- Assesses disease transfer and other aircraft occupant health factors

The FAA works to ensure the safety and efficiency of NAS operations, a critical element of which is operator performance. Through guidelines, handbooks, advisory circulars, rules, and regulations, it provides industry with human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. The Human Factors program research provides the technical information necessary to generate these products and services.

Automation has been cited as a contributing factor in aircraft accidents (e.g., Cali: AA965). Human factors research is examining flight deck automation design, operation, and use and has classified the issues to be addressed.

- Air carrier training initiatives such as the Model Advanced Qualification program (air carrier pilot training program that integrates both technical and crew resource management performance requirements) will allow air carriers to develop and use proficiency-based training.

- The Automated Performance Measuring System will provide airlines the ability to analyze routine operations for dangerous trends and tendencies and will provide insight into the details of daily carrier line operations.
- Validated pre-hire assessments for air traffic controllers, electronics technicians, and transportation system specialists will enable the FAA to select persons with appropriate knowledge, skills, and abilities for each occupation, which will reduce training required after employment as well as attrition due to poor person-job fit.
- The Aviation Medicine Office and the National Institute for Occupational Safety (NIOSH) and Health are examining cabin air quality issues and their effect on passengers and crew.
- Aviation Medicine is also developing:
 - Bioengineering criteria to support aircraft seat and restraint system certification
 - Human performance and ergonomic data to support emergency evacuation regulations and standards
 - Biomedical criteria to support protective breathing equipment and operational procedures certification
 - Biochemical and toxicological criteria supporting use or certification of aircraft interior fire, smoke, and toxicity limits.

Program Area Structure

The Human Factors program addresses operational requirements through research in five technical thrust areas that were agreed to by the FAA, The National Aeronautics and Space Administration (NASA), and the Department of Defense (DOD) in the National Plan for Civil Aviation Human Factors:

Human-Centered Automation. This research focuses on the role of the operator and the cognitive and behavioral effects of using automation to assist humans in accomplishing assigned tasks. Research addresses the identification and application of knowledge concerning the relative strengths and limitations of humans in an automated environment. It investigates the implications of computer-based technology in designing, evaluating,

and certifying controls, displays, and advanced systems.

Selection and Training. This research strives to:

- Understand the relationship between human abilities and aviation task performance
- Enhance the measures and methods of predicting current and future job/task performance
- Establish a scientific basis for the design of training programs, devices, and aids for individuals and teams
- Define criteria for assessing future training requirements
- Identify new ways to select aviation system personnel

Human Performance Assessment. Research in this area identifies the intrinsic cognitive and decisionmaking factors for individuals and teams that determine how well they are able to perform aviation tasks; characterizes the impact of environmental and individual factors on human performance; and improves and standardizes methods for measuring human performance.

Information Management and Display. Research in this area addresses the presentation and transfer of information among components in the NAS. It seeks to:

- Identify the most efficient and reliable ways to display and exchange information
- Determine what, when, and how one might best display and transfer information to system components
- Design a system to reduce the frequency of information transfer errors and misinterpretations
- Minimize the impact when such errors do occur

Bioaeronautics. Research involves the bioengineering, biomedicine, and biochemistry associated with performance and safety. The objective is to enhance personal performance and safety by maximizing crew and passenger health and physiological integrity. The program consists of three research initiatives:

- Human protection and survival—Investigates protecting humans in decelerative environments, protective breathing equipment, cabin evacuation, and water survival
- Medical and toxicological factors of accident investigation—Investigates Medical and toxicological factors of accidents, including sudden or subtle pilot incapacitation
- Federal Air Surgeon program support—Current clinical investigation, including new vision-correction methods for aviation personnel, aircraft cabin environmental hazards, and air ambulance medical requirements
- A program to survey the nature of in-flight medical emergencies, particularly the effectiveness of defibrillators carried on airliners, also supports the Federal Air Surgeon

Customer/Stakeholder Involvement

The Human Factors program directly supports a number of aviation community initiatives and Congressional mandates:

- 1998 FAA Strategic Plan Mission Goal for Safety: By 2007, reduce U.S. aviation fatal accident rates by 80 percent from 1996 levels. FAA will work with aerospace community to:
 - Build on currently successful efforts to identify root causes of past accidents
 - Use a more proactive analytical approach, with new data sources, to identify key risk factors and intervene to prevent potential causes of future accidents
 - In partnership with NASA, DOD, and other public and private organizations, study issues and technologies to improve policies, procedures, and equipment.
- Office of the Associate Administrator for Research and Acquisitions (ARA) Performance Plan:
 - Goal 1: Contribute to the FAA goal to reduce the fatal aviation accident rate by 80 percent by 2007 as compared to 1994-1996 baseline data
 - Goal 2: Ensure human factors issues are addressed in the acquisition and integration of 100 percent of FAA aviation systems and applications by 2005, including Free Flight Phase 1.

- *The National Plan for Civil Aviation Human Factors*, published in March 1995, with FAA, NASA, and DOD as signatories. This document, which had extensive aviation community participation in its development, outlines a coherent national agenda for human factors and bioaeronautical research and application leading to significant improvements in NAS safety and efficiency.
- The Aviation Safety Plan, through research supporting priority issues associated with crew training, safety data collection and use, application of emerging technologies, and aircraft maintenance procedures and inspection. The Aviation Medicine program significantly contributes to the application of emerging technologies, as highlighted in the Plan.
- Implementation of the FAA report, *The Interfaces Between Flight Crews and Modern Flight Deck Systems*.
- Public Law 100-591 establishes requirements for human factors research and its application. The FY 1998 Department of Transportation Appropriations Act cites human factors as the greatest cause of aviation accidents. The Aviation Safety Research Act of 1988 requires that human factors research be conducted to “enhance air traffic controller performance.” These two Acts support continuing work in human factors analysis of the hazards associated with new technologies, identify innovative and effective corrective measures for human errors, and develop dynamic simulation models of the air traffic control (ATC) system.
- The Radio Technical Commission for Aeronautics (RTCA) “Free Flight Action Plan” specifically addresses recommendations to: establish more flexible decision support systems involving collaborative decisionmaking; conduct human-in-the-loop simulations for assessing controller and pilot perceptions of hazards, risks, and discomfort; measure performance, workload, and situation awareness associated with controller and pilot responses to time and distance; conduct real-time human-in-the-loop simulations to systematically study controller and pilot behaviors, interactions, and effects within NAS environments

that represent dynamic densities and sector configurations anticipated for free flight.

- The Aviation Medicine program is an integral participant and research provider under the FAA, Joint Aviation Authorities, and the Transport Canada Aviation Aircraft Cabin Safety Research Plan (established in 1995). The plan sets forth long-term research goals and ensures coordination between international aviation agencies. Programs within Aviation Medicine that study aircraft cabin environmental quality and the nature and extent of in-flight medical emergencies are a direct result of specific Congressional mandates to study these topics.

Accomplishments

- Developed and field-tested with several airlines a prototype Automated Performance Measurement System (APMS) that allows for gathering and analysis of data from aircraft flight data recorders. This information and analysis capability is used by the Flight Operations Quality Assurance program, a joint FAA and airline venture, to enhance aviation safety.
- Validated use of simulator parameters and flight data for evaluating Advanced Qualification program (AQP) effectiveness
- Developed a model AQP for use by training centers to support air carrier participation in AQP, a proficiency-based approach to pilot training
- Provided crew resource management procedure guidelines for regional airlines
- Validated human performance transfer functions for level B full flight simulator
- Provided recommendations for improved use of automated flight management systems
- Produced and presented the FAA Human Factors Course to increase understanding of the importance of considering the “human factor” in design/acquisition of FAA systems
- Produced and distributed handbook for advanced Crew Resource Management training
- Completed a study of the effectiveness of delivering technical information to line aircraft

- technicians using wireless, portable, pen-based computers that display technical publications
- Initiated a process to integrate shift-change error identification and mitigation processes into the aircraft maintenance error-detection and reporting system
- Developed pilot performance data through flight simulation for use in establishing certification standards for general aviation auto-navigation and control systems
- Directed a large-scale effort to identify and resolve a large number of human factors issues inherent in the STARS display
- Sponsored the National Research Council's two-phase assessment of human factors issues in the air traffic control system and the NAS, and an examination of future automation issues. Distributed two publications: *Flight to the Future—Human Factors in Air Traffic Control*, and *The Future of Air Traffic Control*
- Conducted a human/system performance assessment of the Departure Sequencing Engineering Development Model
- Completed a human factors audit of the Converging Runway Display Aid (CRDA) installed at St. Louis Airport. CRDA is a decision support tool that helps terminal radar controllers efficiently space aircraft arriving on separate, converging runways
- Completed measurement of task-load and document work processes of personnel at maintenance control centers
- Developed guidelines to reduce in-flight sudden/subtle incapacitation
- Evaluated autopsy data from fatal aviation accidents to recommend protective equipment and design practices
- Assessed flight attendant reproductive health hazards
- Reported on the suitability of component tests for showing regulatory compliance with crashworthiness standards for aircraft
- Completed definitive evacuation escape slide angle and strength studies to minimize escape injuries and escape failures

- Developed fit and comfort standards for aviation oxygen mask systems
- Assessed operational hazards of in-flight laser exposure

Research and Development (R&D) Partnerships

The Human Factors program is linked to NASA and DOD under the auspices of the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*. Specific areas of coordinated program execution with NASA include cockpit automation, fatigue, crew resource management, team decisionmaking, air-ground communication, and the Automated Performance Measurement System. DOD joint efforts involve fatigue, team performance, and decisionmaking research. Additionally, the Human Factors Office maintains a membership in the DOD Human Factors Engineering Technical Advisory Group that provides a forum for the coordination of research across a variety of technical areas.

The Human Factors Office participates with the Netherlands National Research Laboratory in flight deck automation research, and with the Office of Aviation Medicine. The Office maintains an active membership on all Society of Automotive Engineering G-10 Human Factors subcommittees related to ongoing and future research areas to ensure transition of the results to standards and guidelines. Members from the National Transportation Safety Board work with the Human Factors Office in the areas of fatigue, flight deck automation, and error mitigation.

The Human Factors Office places grants with universities supporting research on air carrier training, flight deck automation, human performance integrity, and aviation maintenance technician training. Coordinated Free Flight research efforts are conducted with NASA's Ames Research Center. An Interagency Agreement with the U.S. Navy Air Warfare Center focuses on developing training and performance measurement strategies to enhance teamwork in both flight deck crews and air traffic control teams. Receiving special attention are training enhancements that develop aviation teamwork skills and the utility of advanced technologies for delivering team training. Additionally, elements of the controller perfor-

mance research project are conducted in concert with the U.S. Air Force's Armstrong Laboratory. Finally, collaborative research in shift work and fatigue is conducted with the U.S. Coast Guard Reserve and Development Center.

The Office of Aviation Medicine collaborates with NIOSH on a study addressing the cabin environment and flight attendant and passenger symptomatology and diseases. In addition, the office coordinates with the American Society of Heating, Refrigeration, and Air Conditioning Engineers Committee on addressing aircraft cabin air quality status and research.

The Office of Aviation Medicine maintains direct cooperative research processes with the manufacturers of safety products (seats, restraint systems, oxygen masks, evacuation slides, etc.). The Office is also represented on appropriate subgroups of organizations such as the Aerospace Medical Association, the Society of Automotive Engineers (SAE), the Civil Aviation Medical Association, and the Professional Aeromedical Transport Association. It maintains appropriate liaison with the military, either through direct project collaboration (e.g., crashworthiness, eye injury from lasers) or through participation in the Tri-Services Aeromedical Research Panel and the North Atlantic Treaty Organization (NATO) aerospace medical advisory group.

Long-Range View

The FAA is responsible for initiating and maintaining research and development programs that support modernization, regulation, certification, and NAS issues. The FAA is also responsible for initiating proactive research for identifying emerging safety trends. The Human Factors investment strategy will directly support these research efforts to identify and reduce targeted safety issues.

Baseline data will be established to show direct causal relationships between research outputs and accidents and incidents. Research programs will focus on targets that will have the greatest impact on aviation safety. The programs will be multi-year efforts and will require stabilized resources to plan, execute, and complete. Successful implementation of research outputs will require full

partnerships and close cooperation within FAA organizations and the aviation community.

Research strategies will focus on technology, partnerships, and measurements. Methods will be developed to identify interventions to address human performance issues in flight maintenance and air traffic operations. Also, methods will be developed to reduce operational hazards. Regarding partnership strategies, a 5-year, integrated safety research plan will be developed with NASA, addressing long-range, high-payoff priorities. Measurement strategies will be developed to accurately monitor trends and identify opportunities for risk mitigation research.

There is strong public and Congressional interest in maintaining a healthy and comfortable environment for each civil aviation category. A 5-year interagency agreement between FAA and NIOSH began in FY 1997, addressing infectious disease and other health considerations in the aircraft cabin environment.

FAA goals related to minimizing injury, associated pain, necessary rehabilitation, and death as a consequence of aviation accidents make the work of the Aviation Medicine program a critical component of coordinated steps that will increase survivability, which is one of the accepted corporate strategies for decreasing fatal accidents. The Aviation Medicine program will emphasize reducing the severity of injuries encountered in aviation accidents and in such precautionary events as evacuation of passengers from an aircraft after the flight crew recognizes a safety concern. This approach will cut rehabilitation time, decrease medical costs, and improve the quality of life for people who suffer injuries.

In concert with the targets expressed in Challenge 2000 and with FAA's broad commitments to harmonize safety regulations on a global scale, the Aviation Medicine program—collaborating with domestic and international laboratories—will generate research data for use in developing internationally harmonized aviation standards and regulations. Aeromedical Research will be increasingly required to interpret data derived from around the world, and to determine if the data should be accepted or re-collected before being integrated into regulatory considerations and outputs.

A08a Flight-Deck/Maintenance/System Integration Human Factors

GOALS:

Intended Outcomes: The FAA intends to improve air transportation safety by:

- Developing more effective methods for aircrew, inspector, and maintenance technician training
- Developing more human-centered flight controls and displays
- Increasing human factors considerations in certification of new aircraft and equipment design and modification
- Improving aircrew, inspector, and maintenance technician task performance

Agency Outputs: The FAA seeks to ensure the safety and efficiency of operator performance through guidelines, handbooks, advisory circulars, rules, and regulations. It provides industry with human performance information and guidance critical to designing, operating, regulating, and certifying equipment, training, and procedures. The Human Factors program conducts and manages the research that provides the technical information necessary to generate these products and services.

Customer/Stakeholder Involvement: The Human Factors program directly supports a number of aviation community initiatives:

- *1998 FAA Strategic Plan Mission Goal for Safety.* By 2007, reduce U.S. aviation fatal accident rates by 80 percent from 1996 levels; ARA FY 1999 Performance Plan:
 - Goal 1 Contribute to the FAA goal to reduce the fatal aviation accident by 80 percent by 2007 as compared to 1994–1995 baseline data
 - Goal 2 Ensure human factors issues are addressed in the acquisition and integration of 100% of FAA aviation systems and applications by 2005, including Free Flight Phase 1
- The *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application* was published in March 1995, with FAA, NASA, and DOD as signatories. This document, which had extensive aviation com-

munity participation in its development, outlines a coherent national agenda for human factors research and application leading to significant improvements in NAS safety and efficiency.

- The *Aviation Safety Plan*, through research supporting priority issues associated with four of the six workshops: crew training, safety data collection and use, application of emerging technologies, and aircraft maintenance procedures and inspection.
- Implementation of the FAA report, *The Interfaces Between Flight Crews and Modern Flight Deck Systems*.

The Human Factors program is also responsive to Public Law 100-591, which establishes requirements for human factors research and its application.

Accomplishments: The program output of data packages, models, and regulatory documents include:

- Developed, and currently field-testing with several airlines, a prototype APMS that allows gathering and analysis of data from aircraft flight data recorders. This information and analysis capability provides the backbone for the Flight Operations Quality Assurance program, a joint FAA and airlines venture to enhance aviation safety.
- Developed an advisory circular and handbook on crew resource management for aircrew members
- Developed a model AQP to support regional air carrier participation. AQP is a proficiency based approach to pilot training that is considered to be highly effective and efficient for aircrew training
- Published the *Aviation Maintenance Human Factors Guide*
- Provided educational outreach to the aviation community through the NASA/FAA fatigue countermeasures training module
- Developed pilot performance data, through flight simulation, for use in establishing certi-

fication standards for general aviation auto-navigation and control systems

- Developed an aircraft certification human factors and operations checklist for stand-alone Global Positioning System receivers

R&D Partnerships: The program is linked to NASA and DOD under the auspices of the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*. Specific areas of coordinated program execution with NASA include cockpit automation, fatigue, crew resource management, team decisionmaking, air-ground communication, and automated performance measurement system. DOD joint efforts involve fatigue, team performance, and decision-making. Additionally, the FAA is represented on the DOD Human Factors Engineering Technical Advisory Group, a forum for coordinating research across a variety of technical areas. The FAA participates with the Netherlands National Research Laboratory in flight-deck automation as well as on all of the Society of Automotive Engineers G-10 human factors subcommittees related to our research areas to ensure transition of the results to standards, guidelines, etc. Members from the National Transportation Safety Board have worked with the program in the areas of fatigue, flight deck automation, and error mitigation. The FAA also has extended grants to 10 universities supporting research on air carrier training, flight deck automation, and aviation maintenance technician and inspector training.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

Selection and training

- Provided “proceduralized” crew resource management guidelines for regional airlines
- Validated human performance transfer functions for level B full flight simulator
- Researched and developed input for maintenance resource management handbook
- Completed guidelines for maintenance technician situation awareness training
- Developed the AQP database, incorporating user comments on the task analysis and task listing components, and incorporated a per-

formance database that links tasks to performance indicators

- Provided air carrier training data analysis and tools tailored to scenario-based evaluation

Human performance assessment

- Completed advanced APMS prototype
- Completed user needs studies at air carriers participating in APMS development
- Developed and implemented phase I APMS at partner air carriers
- Developed mapping of flight data parameters onto AQP qualification standards

Human-centered automation

- Completed limited functionality certification job aid
- Completed assessment of current air carrier and manufacturer automation training programs
- Completed human factors guidelines for assessing advanced general aviation transportation experiments (AGATE) cockpit controls/displays
- Initiated/coordinated comprehensive research program addressing cockpit automation

Information management and display

- Completed software tools for enhanced maintenance documentation

KEY FY 2000 PRODUCTS AND MILESTONES:

Selection and training

- Provide industry and FAA guidance addressing training crewmember use of advanced automated systems
- Provide methods to integrate quantitative indices of operational performance data with pilot training data to evaluate the effectiveness of flight training programs, specifically AQP
- Provide methods of using scenario-based evaluation and analysis techniques to identify troublesome trends before accidents occur, and provide appropriate training technologies to remedy identified weaknesses

Human performance assessment

- Define general aviation pilot decisionmaking skills required for training module development
- Complete research and develop maintenance resource management handbook
- Provide expanded APMS methodologies and analysis capabilities so that air carriers can collect and analyze increasing amounts of flight and simulator data

Human-centered automation

- Complete fully functional certification job aid
- Provide industry and FAA guidance addressing training for automated cockpits; these guidelines will encompass the performance difficulties associated with increased coupling, complexity, and autonomy of modern cockpit technology
- Provide human factors evaluation for AGATE flight systems configurations
- Develop certification guidelines for integrated technology in general aviation cockpits

Information management and display

- Develop guidelines for the use of simplified English in aircraft maintenance technician instructions and documentation
- Develop and implement guidelines for maintenance error investigating and reporting systems
- Develop flight data recording and analysis capability for flight simulators

FY 2000 PROGRAM REQUEST:

The program will continue to focus on providing technical information and consultation to improve aircrew, inspector, maintenance technician, and aviation system performance. It will emphasize developing guidelines, tools, and training to enhance error-capturing and mitigation capabilities in the flight deck and maintenance environments, as well as developing human factors tools to ensure that human performance considerations are adequately addressed in the design and certification of flight decks and equipment

1999 FAA NATIONAL AVIATION RESEARCH PLAN

A08a - Flight Deck/Maintenance/System Integration Human Factors Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
081-110 Flightdeck/Maintenance/System Integration Human Factors						
Selection and Training						
Develop Maintenance Resource Management Handbook	◆	◇	◇			
Develop AQP Database Incorporating User Comments	◆	◇	◇	◇		
Provide Air Carrier Training Data Analysis and Tools Tailored to Scenario-Based Evaluation		◇	◇	◇	◇	◇
Provide Industry and FAA Guidance Addressing Training Crewmember Use of Advanced Automated Systems	◆	◇	◇	◇	◇	◇
Develop the Advanced AQP Database with User Comments		◇	◇			
Implement Advanced GA Training Techniques	◆	◇	◇	◇	◇	◇
Completed Guidelines for Maintenance Technician Situation Awareness Training	◆					
Human Performance Assessment						
Complete Advanced Prototype APMS	◆	◇	◇			
Develop and Implement Phase I APMS at Partner Air Carriers	◆	◇	◇	◇		
Develop APMS data filtering, Automated Flight Analysis Modules	◆	◇	◇	◇		
Define GA Decision Making Skills Required for Training Module Development	◆	◇				
Complete Research on Identification and Classification of Aviation Maintenance Error Reporting Systems	◆	◇				
Human Centered Automation						
Initiate/Coordinate Comprehensive Research Program Addressing Cockpit Automation	◆	◇	◇	◇		
Provide Preliminary Recommendations for Improved Training for Automated Flight Management Systems	◆	◇	◇	◇	◇	
Develop a Tool Kit of Job Performance Aids to Help Certification Personnel and Designers Assess Automated Flight Decks	◆	◇				
Provide Industry and FAA Guidance Addressing Training for Automated Cockpits	◆	◇	◇	◇	◇	◇
Provide Industry and FAA Guidance to Effectively Address Cultural Influence on Crewmember Use of Automated Systems	◆	◇	◇			
Develop Usability Evaluation Tool for Electronic Flight Bag	◆	◇	◇			
Develop Certification Guidelines for Head-up Displays	◆	◇	◇			
Validate Pilot/Controller Integration Performance Requirements for Free Flight	◆	◇	◇	◇	◇	
Provide Human Factors Evaluation for AGATE Flight Systems	◆	◇				
Information Management and Display						
Complete Software for Enhanced Maintenance Documentation	◆	◇	◇	◇		
Develop and Implement Guidelines for Maintenance Error						

Budget Authority (\$ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	7,857	8,430	10,365	8,497	7,289
Personnel Costs	2,760	2,048	1,814	1,940	2,367
Other Costs	565	420	371	563	486
Total	11,182	10,898	12,550	11,000	10,142

A08b Air Traffic Control/Airway Facilities Human Factors**GOALS:**

Intended Outcomes: The FAA intends to:

- Contribute to future concepts of NAS operation by building an integrated infrastructure that enhances human/system efficiency
- Increase understanding of the human factors of emerging technologies, changing human roles and responsibilities, and evolving procedures to help optimize human performance
- Promote integration of human factors products into advanced operational concepts and the NAS architecture
- Develop enhanced measures of human performance and increase understanding of factors that can lead to performance decrement

Agency Outputs: The products of this program will include: reference data and criteria; methods, tools, and measures; facility and equipment design recommendations and specifications; operational task load and performance baselines; expert human factors guidance; test and evaluation checklists, procedures, and determinations; and evaluative findings focused on human factors in present and future operational environments. These products—shared with the international aviation community—will provide essential assistance to FAA's Air Traffic Services for implementing and enhancing advanced operational concepts, including the systems, subsystems, and procedures integral to these concepts.

Human factors research and development products will include:

- Models of performance and efficiency based on system variables.
- Development of workload performance measures and models for existing systems and new technologies
- Human/system productivity enhancement technology
- Advanced methods and technology for training operational personnel
- Tests and criteria for selecting operational personnel

- Human factors recommendations for designing operational facilities and control rooms

Customer/Stakeholder Involvement: The Air Traffic Services (ATS) Human Factors Research program is directly mapped to and supports:

CONOPS 2005

- In 2005, the NAS will take a human-centered approach to maximize efficient delivery of air traffic services to users. Thus, system processes and workstations are designed to expedite information exchange among NAS information systems, service providers, and users. Human factors analyses and human-in-the-loop simulations have determined the appropriate allocation of tasks between service providers, users, and automation systems. Moreover, issues such as situation awareness, workload, and computer-human-interface (CHI) design have been resolved by incorporating human factors. This approach ensures that the human capabilities and limitations of users and service providers remain a primary consideration in systems development. NAS evolution uses a clear transition strategy for each operational capability and employs a human-centered approach for implementing new operational concepts and supporting technologies.

National Airspace System Architecture Version 4.0

- The NAS architecture specifies a broad range of research activities regarding the implications of human factors. These activities will acquire and then apply the information necessary to understanding human capabilities and limitations in each functional area. Human factors engineering will then be applied to identify and resolve risks and to assess costs, benefits, and tradeoffs.

Air Traffic Management (ATM) Research, Engineering, and Development Advisory Committee (REDAC) Recommendations

- The FY 2000 ATS Human Factors R&D program is a direct result of collaboration with representatives of Air Traffic Services and other FAA stakeholders in the ATM Research

and Development Agenda Team (ARDAT) to specifically address the recommendations of the Congressionally mandated REDAC. The NAS ATM R&D Committee has reported that “The culture within the FAA has not supported the development of a rigorous technical community focused on NAS related areas such as large-scale systems engineering; operations research; communication, navigation and surveillance (CNS); or operational human factors.” Human factors considerations need to be incorporated as a key part of the preliminary concept of operation and system design efforts.

Recommendation: Increase emphasis on understanding the implications of various Free Flight architectural alternatives on pilot and controller performance, and incorporate this understanding early in the NAS architecture evolution process.

Some of the human performance issues¹ that appear to be important to “Free Flight” include:

- Balance of air-ground responsibility.
- Use of structure by controllers to organize traffic.
- Ability of controllers to deal with flexible airspace (e.g., dynamic resectorization).
- Monitoring and out-of-loop issues for pilots and controllers.
- Trust in automation
- Conflict resolution strategies
- Collaborative decisionmaking behavior
- Gaming behavior of pilots, airlines, and controllers
- Shared situational awareness
- Intervention strategies
- Communication requirements

ARA Performance Goals²

Goal 1. Safety: Contribute to the FAA goal to reduce the fatal aviation accident rate by 80 percent

by 2007 as compared to 1994-1996 baseline data.”

Goal 2. Human Factors: Ensure human factors issues are addressed in the acquisition and integration of 100 percent of new and modified FAA aviation systems by 2005, including Free Flight Phase 1.

The FAA Strategic Plan states that “human factors is one of the most important areas for improving safety.”

- The *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*. This document, published in March 1995, with FAA, NASA, and DOD as signatories, had extensive aviation community participation in its development, and outlines a coherent national agenda for human factors research and application leading to significant improvements in NAS safety and efficiency.

Accomplishments: The program has performed or sponsored the following research and resulting products:

- Developed an enhanced visual scanning methodology for application in display design
- Conducted a study of the impact of shared separation on controller performance
- Completed an auditory alarm database
- Conducted a comprehensive assessment of the STARS operational radar display, and maintenance control workstations; identified a significant number of human factors issues deemed to have a negative impact on human/system performance; convened and facilitated a multidisciplinary work group consisting of representatives from Human Factors, ATS, the Standard Terminal Automation Replacement System (STARS) program office, National Air Traffic Controllers Association (NATCA), LMR, MITRE Corporation, and other stakeholders to resolve these problems; a notable product of the work group was a de-

1 Source: Subcommittee Report of the NAS ATM R&D to R,E&D Advisory Committee, March 25, 1997.

2 Source: Performance Agreement Between The Secretary of Transportation and The Federal Aviation Administration, Fiscal Year 1998; 1998 FAA Strategic Plan.

finite process to address and resolve human factors issues inherent in other NAS systems.

- Developed performance baselines for STARS, the display system replacement (DSR), and PVD for use in measuring the impact of future system enhancements
- Developed a new selection instrument for Airway Facilities technicians
- Collaborated with ATS to develop a new selection instrument for air traffic controllers (ATSAT)
- Sponsored the National Research Council's assessment of human factors issues in the air traffic control system. Under this grant, the NRC has conducted informative briefings for FAA and Congress and published two books, *Flight to the Future—Human Factors in Air Traffic Control* and *The Future of Air Traffic Control*. These volumes, authored by aviation human factors experts, contain a wealth of information, conclusions, and recommendations on the present and future ATC system.
- Published an extensive book of information and advice on human factors issues in the design and evaluation of ATC systems and subsystems (750 pages). To date, the book and its associated electronic checklist have been widely distributed within the FAA to ATS and Integrated Product Team (IPT) customers for internal use.
- Validated the current air traffic controller pre-training screen-selection instrument to ensure that it was both effective and free of any race, gender, or cultural bias
- Completed development of en route Systematic Air Traffic Operations Research Initiative (SATORI), a research tool that uses routinely recorded ATC computer and voice data to recreate and display air traffic control operational incidents in the same way that they appeared on the controller's radar screen. SATORI has been transitioned to ATS which procured it for installation in all air route traffic control centers to study operational errors
- Conducted detailed human factors assessment of the Air Traffic Control System Command Center operational environment. Air Traffic

Management used results as the basis for extensive redesign

- For the Airway Facilities Operations Management Team, measured task load and documented work processes of personnel at present maintenance control centers

R&D Partnerships

NASA, DOD, and FAA are cooperative partners in developing and implementing the *National Plan for Aviation Human Factors: An Initiative for Research and Application*. This document lays out a coherent national agenda for human factors research and provides the conceptual framework for the Air Traffic Services (ATS) human factors program. Coordinated research efforts are conducted with NASA's Ames Research Center in the areas of Free Flight and shift work induced fatigue and associated countermeasures. Additionally, elements of the controller performance research project are conducted in concert with the U.S. Air Force's Armstrong Laboratory. Internationally, research results on development and validation of controller applicant selection methods are shared between project leaders in this program and their functional equivalents in Sweden and Denmark.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

- Provide initial results of fatigue countermeasures study
- Validate strategies for human error prevention/mitigation in Airway Facilities (AF) maintenance control
- Develop strategies for human error prevention/mitigation in AF Maintenance Control Centers
- Provide guidelines for color-coding information on ATC displays
- Complete study of ATC complexity factors and provide guidance for their display
- Revise and update human factors handbook and electronic checklist
- Revise and update human factors design guide
- Conduct assessment of DSR implementation training

- Complete baseline of taskload and performance and selected air route traffic control centers (ARTCC)

KEY FY 2000 PRODUCTS AND MILESTONES:

Research to be conducted will affect a variety of ATS programs. These efforts are grouped into the following broad categories:

ATC Information Display and Interface Design

- A baseline of human performance levels associated with current information technologies/displays and input methodologies
- Guidelines for information display and interface design
- Guidelines to support common interface design across the NAS

Decision Support System (DSS) and Collaborative Decisionmaking

- Baselines of human performance levels associated with current decision processes proposed for support by DSS's
- Human-centered design guidelines for DSS capabilities
- Guidelines relative to DSS accuracy, sensitivity, and false alarm rates
- Guidelines to support collaborative decision-making across NAS users

Airspace Design and Procedures Human Factors

- A baseline of human performance levels associated with current sector operations (e.g., System Command Center, traffic management units (TMU), ATC)
- Human factors guidelines for airspace design and airspace display integration
- Human factors guidelines for procedures associated with alternative airspace design concepts (e.g., communications, coordination, etc.)
- Documentation of human factors requirements associated with system integration of new airspace design concepts (e.g., inter/in-

tra-facility, area, sector, and position human factors requirements under current airspace concepts)

NAS Maintainability

- Human performance metrics to support evaluation of NAS maintainability
- Guidelines for the design of operational facilities that support the role of the human in maintenance operations
- Evaluation of the potential impact of incorporating new technologies into the NAS maintenance work environment

General Human Factors Research

- Human performance metrics for NAS system operators
- Selection methodologies, guidelines, and criteria for NAS personnel
- Training methodologies and guidelines for NAS personnel
- Guidelines for training interventions directed at team performance of NAS personnel
- Human performance guidelines for implementing alternative work schedules (e.g., rotating shift work)
- Human performance guidelines to mitigate/counteract fatigue
- Guidelines, strategies, and specific recommendations to facilitate workforce transition to new concepts of operation

FY 2000 PROGRAM REQUEST:

The FY 2000 research program reflects a heightened emphasis on working with ATS to meet the pressing challenge of successfully fielding new technologies and procedures over the next several years. Research projects focus on providing timely information to answer critical human factors questions associated with these new systems and procedures (such as Free Flight) and thus help to optimize human performance in the evolving and increasingly complex NAS.

1999 FAA NATIONAL AVIATION RESEARCH PLAN

A08b - Air Traffic Control/Airway Facilities Human Factors Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
082-110 Air Traffic Control/Airway Facilities Human Factors						
Information Display & Interface Design						
Guidelines for Information Display & Interface Design	◆	◇	◇	◇	◇	◇
Guidelines for Common Information Display & Interface Design across the NAS			◇	◇	◇	◇
STARS EDC, ISC & Tower Display Usability Assessments	◆					
Visual Scanning Assessments of Display Design	◆	◇	◇	◇	◇	◇
Measures of ATC's Situation Awareness (SA). Guidelines to Enhance SA	◆	◇	◇	◇	◇	
Decision Support & CDM						
Human-centered Guidelines for DSS Capabilities	◆	◇	◇	◇	◇	◇
Guidelines to Support Collaborative Decision-making	◆	◇	◇	◇	◇	◇
Guidelines Relative to DSS Accuracy, Sensitivity and False Alarm Rates	◆	◇	◇	◇	◇	
Operational Impact of Shared Separation Responsibility, Collaborative Decision-making	◆	◇	◇	◇	◇	◇
Airspace Design & Procedures						
Human Factors Guidelines for Airspace Design and Procedures	◆	◇	◇	◇	◇	◇
Roles & Responsibilities of ATCS in FF	◆	◇	◇	◇	◇	◇
Define Human Factors Issues for Transition from Unconstrained to Constrained Airspace in Free Flight	◆	◇	◇	◇	◇	
NAS Support						
Human Performance Metrics to Support Evaluation of NAS Maintainability		◇	◇	◇	◇	◇
Guidelines for the Design of Operational Maintenance Facilities	◆	◇	◇			
Human Error Prevention/Mitigation in AF MCC's	◆	◇	◇	◇		
Evaluation of Impact of New Technologies on AF Environment	◆	◇	◇	◇	◇	◇
General Human Factors						
Human Performance Metrics for NAS System Operators	◆	◇	◇			
Selection Methodologies for Next-Generation Air Traffic Controllers & NAS Technicians	◆	◇	◇	◇	◇	
New Training Methodologies	◆	◇	◇	◇	◇	◇
Guidelines for Enhancing Team Performance	◆	◇	◇	◇	◇	
Human Performance Guidelines to Mitigate/Counteract Fatigue	◆	◇	◇	◇		
Baselines of Human/System Performance	◆	◇	◇	◇	◇	◇
Recommendations for Workforce Transition to New CONOPS	◆	◇	◇			

Budget Authority (\$ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	4,836	4,356	5,454	5,711	4,897
Personnel Costs	4,286	3,528	3,773	3,117	5,034
Other Costs	878	722	773	1,172	1,305
Total	10,000	8,606	10,000	10,000	11,236

A08c Aeromedical Research

GOALS:

The FAA safety mission dictates that:

- Existing injury and death patterns in civilian flight misadventures be meticulously reviewed
- Recommendations for protective equipment and procedures be developed
- Options be evaluated on behalf of FAA regulatory and medical certification staff charged with proposing safety regulations addressing all aircraft cabin occupants

A concurrent mission is to identify pilot, flight attendant, and passenger medical conditions that are incompatible with in-flight clinical and physiological demands on the occupant, both in the absence and presence of flight emergency conditions.

Intended Outcomes: The Aeromedical Research program addresses improved health, safety, and survivability of aircraft passengers and aircrews. It identifies human failure modes (physiological, psychological, clinical) both in uneventful flight and during civil aircraft incidents and accidents. Formal recommendations for counteracting measures are derived from in-house research.

The FAA is able to develop bioaeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments as a base for regulatory action to enhance appropriate human performance. Pilot medical and flight histories and information from accidents and incidents are reviewed to develop new medical criteria, standards, and assessment/certification procedures to ensure full performance capability. Assessments of flight attendant and passenger work, behavioral, and disease issues are used to propose guidelines for actions to improve the health and safety of cabin occupants.

Agency Outputs: The program has developed the following criteria for use in regulatory and certification processes:

- Quantitative bioengineering criteria to support aircraft seat and restraint system certification

- Quantitative biomedical criteria to support protective breathing equipment and operational procedures certification
- Quantitative biochemical and toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits
- Quantitative biomedical criteria to support flotation and onboard rescue equipment certification
- Identification of medical/toxicological factors and human factors in aviation incidents and accidents
- Recommendations for aircrew medical criteria, standards, and assessment/certification procedures
- Quantitative data about the occupational health status of flight attendants to support regulatory oversight
- Quantitative data about passenger behavior and health to support regulatory oversight

Customer/Stakeholder Involvement: The Aeromedical Research program contributes to meeting the 1998 FAA Strategic Plan Mission Goal for Safety and ARA FY 1999 Performance Plan Goals for Safety and Human Factors. The program provides the primary bioaeronautical research (note: defined as the bioengineering, biomedicine, and biochemistry issues associated with safety and performance) called for in the *National Plan for Civil Aviation Human Factors of 1995*. (This plan committed to major deliverables referenced in the system safety goals of the FAA Strategic Plan of the following year.)

The program contributes significantly to the application of emerging technologies, as highlighted in the February 1996 FAA Aviation Safety Plan. The program is an integral participant and research provider under the FAA, Joint Aviation Authorities (JAA), and Transport Canada Aviation (TCA) Aircraft Cabin Safety Research Plan. The plan was developed in 1995 as a coordinated, living plan to maximize the cost-benefit of aircraft cabin safety research internationally.

The program develops International Civil Aviation Organization (ICAO) initiatives addressing the health of the aircraft occupant (crew and passenger) before final FAA recommendations are provided to ICAO. This program is the only FAA research component that can legally access confidential medical data about pilots for epidemiological research studies approved by FAA's institutional review board for use of human test subjects. Multiyear collaborative studies performed by the FAA and NIOSH into flight attendant and passenger symptomatology and diseases are funded by this budget item to satisfy the mandate placed by Congress upon the agencies in the FY 1994 Appropriation Act.

Accomplishments: Based on aeromedical research at the Civil Aeromedical Institute, the FAA issued an advanced notice of proposed rulemaking concerning usage and design of child restraints on aircraft. The output of this program's research is permitting the FAA and National Highway Traffic Safety Administration to revise the testing requirements in Federal Motor Vehicle Safety Standard 213, which covers the design of child restraints for use in aircraft. Quantitative data were provided on various prototypes of aircraft-specific child restraints being developed as commercial products targeted for airlines. Specialized quantitative crashworthiness assessments for aircraft continued, including side-facing aircraft seats and the use of state-of-the-art anthropomorphic test dummies with enhanced injury assessment capabilities.

Data are continuously provided to the research sponsor on the role of toxicological and clinical factors associated with each aircraft accident and significant incident. Current findings indicate that about one in six pilots fatally injured in a civilian aircraft accident shows evidence of prescription drug use; one in four had taken an over-the-counter drug, one in 25 had ingested significant positive alcohol, and 1 in 20 had used a significant amount of a controlled dangerous substance. Long-term aviation forensic and epidemiological research has helped the FAA to identify human factor roles in accident/incident causation. Specialized clinical evaluations were applied to cases associated with aircraft decompression. Probable seizures and other factors indicative of the pilot's inability to perform were evaluated.

R&D Partnership: Several of these partnerships (e.g., FAA/JAA/TCA; FAA/NIOSH) have been cross-referenced in the "Customer/Stakeholder Involvement and Accomplishments" sections above.

In addition, in each program area output category, the FAA maintains direct cooperative research processes with all the manufacturers responsible for the safety products listed (seats, restraint systems, oxygen masks, evacuation slides, etc.). FAA investigators also maintain memberships on every Society of Automotive Engineers committee addressing safety research conducted under this program. The agency maintains a liaison with the American Society of Heating, Refrigeration, and Air Conditioning Engineers committee, which addresses aircraft cabin air quality status and research. Besides active involvement in the FAA/JAA/TCA process of oversight for safety research, participants in this program serve on appropriate subgroups of organizations such as the Aerospace Medical Association, the Civil Aviation Medical Association, and the Professional Aeromedical Transport Association. Appropriate liaison with the military is maintained either through direct project collaboration (e.g., crashworthiness, eye injury from lasers) or through the more global participation in the TriServices Aeromedical Research Panel or NATO aerospace medical advisory groups.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS

The following program results have been completed or are expected to be achieved in FY 1999:

- Performed epidemiological assessment of toxicology factors from fatal civilian aviation accidents
- Developed guidelines to reduce in-flight sudden/subtle incapacitation
- Evaluated autopsy data from fatal aviation accidents to determine protective equipment and design practices
- Assessed flight attendant reproductive health hazards (Congressionally requested FAA-NIOSH study)
- Developed improved fit and comfort standards for oxygen mask systems

- Assessed operational hazards of in-flight laser exposure

KEY FY 2000 PRODUCTS and MILESTONES

The following program activities are scheduled for FY 2000:

- Conduct epidemiological assessment of toxicology factors from fatal civilian aviation accidents
- Compare toxicology findings at time of flight physical to post-accident data
- Develop guidelines to reduce in-flight sudden/subtle incapacitation
- Evaluate autopsy data from fatal aviation accidents to determine protective equipment and design practices
- Report on guidelines for aircraft cabin occupant health maintenance
- Develop a model of disease transmission via aerosols in an aircraft cabin environment
- Evaluate the suitability of using analytical modeling as a substitute for evacuation tests in certifying new passenger aircraft
- Develop improved fit and comfort standards for oxygen mask systems

- Report the frequency and nature of in-flight medical emergencies and use of defibrillators on commercial aviation flights

FY 2000 PROGRAM REQUEST:

The Office of Aviation Medicine encounters complex medical decisions during initial and followup medical assessments of airmen who request special medical issuances (e.g., cardiac conditions, neurological deficits, etc.) to permit them to continue flying. The prospective epidemiological assessment of special issuance methodology and medical outcomes in the airman population is required to ensure that medical issuances do not result in unexpected or increased aircraft accident or incident rates.

Ongoing research projects will:

- Develop safer aircraft cabin evacuation approval guidelines and safer field applications under operational conditions
- Reduce head, neck, and extremity injuries in aircraft crash environments
- Evaluate trends in toxicology and clinical findings from all major civil aviation aircraft crashes
- Develop guidelines for aircraft cabin crew and passenger environmental management

1999 FAA NATIONAL AVIATION RESEARCH PLAN

A08c - Aeromedical Research Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
086-110 Aeromedical Research						
Cabin Health and Environmental Guidelines						
Assessment of Flight Attendant Reproductive Health Hazards	◆	◇	◇	◇		
Report on Guidelines for Aircraft Cabin Occupant Health Maintenance	◆	◇	◇	◇	◇	
Development of a Model of Disease Transmission Via Aerosols in an Aircraft Cabin Environment		◇				
Human Protection/Survival in Civil Aviation						
Analyze the Suitability for Component Tests as an Alternative for Showing Regulatory Compliance with Crashworthiness Standard for Aircraft	◆	◇	◇	◇		
Assess Impact Protection Performance of Aircraft Seating Systems, Including Child Restraints	◆	◇	◇	◇	◇	◇
Develop Performance-Based Narrow and Wide Bodied Aircraft Cabin Evacuation Approval Guidelines	◆	◇	◇	◇	◇	◇
Report on Suitability of Aircraft Cabin Evacuation Modeling as a Partial Replacement for Evacuation Tests with Human Subjects	◆	◇	◇	◇		
Implement Dual Aisle Evacuation Model					◇	
Development of Improved Oxygen Mask Fit and Comfort Standards	◆	◇				
Analyze the Influence of Cabin Crew Duty Stations on Evacuation Performance of Passenger Aircraft in Panic Situations	◆					
Survey Parents Flying With Small Children on Their Likelihood to Divert to Other Modalities if Child Restraints are Required		◇				
Survey of In-flight Medical Emergencies and Defibrillator Usage on Commercial Airline Flights		◇				
Medical/Toxicology Factors of Accident Investigations						
Perform Epidemiological Assessment of Toxicology Factors from Fatal Civilian Aviation Accidents	◆	◇	◇	◇	◇	◇
Develop Guidelines to Reduce In-flight Sudden/Subtle Incapacitation	◆	◇	◇	◇	◇	◇
Compare Toxicology Findings at Time of Flight Physical to Post-Accident Data	◆					
Evaluate Autopsy Data from Fatal Aviation Accidents to Determine Protective Equipment and Design Practices	◆	◇	◇	◇	◇	◇
Reported on the Impact of the Drug Abatement Program on Aviation Accidents/Incidents	◆					
Develop Toxicological Test to Distinguish Between Ingested and Post-Mortem Alcohol					◇	

Budget Authority (\$ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	0	0	0	313	394
Personnel Costs	2,075	3,320	3,320	3,155	3,858
Other Costs	425	680	680	597	577
Total	2,500	4,000	4,000	4,065	4,829

